Japan's Approach to China's Control of Rare Earth Elements

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Rare Earth Elements

Japan has been dealt a number of blows over the past few years which have put the country's high-tech production capacity at risk. Most recently the massive earthquake and subsequent tsunami that hit Japan in March has directly affected production efforts through rolling blackouts and damaged equipment. Another issue, and one that has been missed by public scrutiny, is the country's struggle to obtain steady supplies of certain key materials needed to produce its high-tech products. Some of those key ingredients are rare earth elements (REEs), of which China has been cutting back export quotas. China has also reportedly announced that it was going to create a REE strategic reserve, a measure that some analysts feel will give the country more control over the industry. In an industry that is ever changing, other countries, whose economies and national security depend on technologies produced with REEs, could learn by Japan's example.

While REEs have long been in the cross-hair of industry analysts, the issue of REE production and supply increased its public spotlight in 2010 after a territorial dispute between China and Japan over the Senkaku/Diaoyou islands during which China imposed a de facto ban on all rare earth exports to Japan. The ban, according to Japanese Economy, Trade, and Industry Minister Akihiro Ohata, further reinforced the idea that the country needed "to craft a long-term strategy to procure rare earths" (Kyodo World Service, October 1, 2010).

China first began cutting back export quotas for REEs in 2006. Japan, however, began to take action to reduce its reliance on its neighbor by early 2007. Dudley Kingsnorth, executive director of the rare earth consulting company Industrial Minerals Company of Australia (IMCOA), is forecasting global demand to increase from 124,000 tons annually in 2010 to 250,000-300,000 tons by 2020. Of this amount, he expects 110,000 to 130,000 tons to account for the rest of world (ROW) demand [1]. In what could be deemed a race for rare earth elements, Japan has already been placing itself at an advantage by taking early action.

REEs are the 15 elements that comprise the family of lanthanides on the periodic table, plus yttrium and scandium. These metals are vital to the production of hundreds of modern technologies such as cell phones, i-Pods, computer hard drives, green technologies, and critical military weapons systems. China dominates the industry, producing over 95 percent of the world's REEs, but the country has been steadily cutting back export quotas, causing worldwide concern [2]. These cuts are a result of several factors including China's desire to stomp out illegal activity, consolidate the industry and stockpile the metals. These cuts, while seemingly necessary for China, enslave nations to the whims of the country's production quotas. Meanwhile, Japan has been seeking to come up with alternatives over the past five years.

While Japan's consumption of REEs has been increasing somewhat steadily over the past three decades, imports from China continue to go down. In December, imports were at 4,080 tons after trade resumed following China's de facto ban on shipments. In January Japan imported 1,783 tons from China. In February, that number dropped to 1,138 tons (Reuters, March 30). In 1995, the country consumed 7,654 metric tons. In 2000, that figure rose to 13,690 metric tons. In 2005, Japan consumed 18,855 metric tons. Prior to the earthquake and subsequent tsunami that occurred in March, Sojitz Corporation, a Tokyo based trading company and one of Japan's largest rare earth importers estimated that Japan would use 32,000 tons of rare earths in 2011 [3]. Experts estimate that in the near term, Japan's consumption rate will decrease as the country struggles to regain its footing in the production of high tech products and that the country's consumption rate in 2011 will be less than originally forecasted. The problem is that Japan does not possess any REEs of its own, forcing the country to rely wholly on imports, approximately 90 percent of which come from China (Japan Today, October 8, 2010). Therefore, because of its already tight supplies, Japan will likely continue to seek alternatives outside of China.

History of Japan's Rare Earth Elements Industry

Japan used REEs as early as the 1940s when the country first saw their value as polishing agents and began producing lighter flints. By the 1960s, research, development and the use of REEs in the country expanded. By 1973, Japan began producing samarium cobalt (SmCo) magnets. Two years later Sony was using these magnets in their Walkman radios. In 1982, the Rare Earth Study Association was established. The name of the organization changed to The Rare Earth Society of Japan in 1995. In 1985, Japan began producing neodymium iron boron magnets (NdFeB), which are the strongest magnets available on the market today and make miniaturization possible [4].

Over the past two decades, Japan transferred some of its production bases to China, a strategic move to help Japan ensure future supplies. Today, however, due to China's steady export cuts and proven ability to use its rare earth resources as a political bargaining chip, Japan no longer feels comfortable relying on China. As a result, Japan has been seeking a more diverse supply by creating joint ventures and signing supply agreements with countries having known reserves of REEs. In addition, Japan has been actively pursuing other options, including recycling, and developing alternative materials that will lessen the country's dependence on REEs.

Diversifying Supply

Figure 1 (See PDF)

The global demand for Japanese products is what drives Japan's demand for REEs. For example, Japan is a major producer and exporter of sintered rare earth magnets and NdFeB alloys, nickel-metal hydride batteries, auto catalysts, digital cameras, fluorescent lamps, and others. The country is also the largest global producer of hybrid electric vehicles (HEV).

HEVs rely heavily on REEs. According to IHS Automotive, an organization that provides automotive market forecasting services and strategic advisory solutions to automotive manufacturers, suppliers, and financial organizations, the rate of production of Japanese HEVs has increased steadily over the past decade. In 2007, Japan produced 443,253 units. By 2010, that number nearly doubled to approximately 883,000 [5]. According to some estimates, HEVs contain up to 25 pounds of REEs. For example, NdFeB magnets are used in electric motors because of their high efficiency and light weight. Lanthanum and cerium are used in the hybrid NiMH batteries [6].

The increase in demand for HEVs, coupled with China's cuts in rare earth quotas, has prompted Japanese companies, such as Toyota Motor Corporation, to seek REEs elsewhere outside of China to ensure production is not affected.

Beijing began cutting export quotas for REEs in 2006. By early 2007, Hiroshi Okuda, a senior advisor to Toyota Motor Corporation, was concerned enough to organize a forum on natural resources and diplomacy (Asahi Shimbun, February 4, 2008). In March 2007, Okuda began asking the question: "Is there a way we could purchase an entire mine?" [7]. Soon after, Toyota Tsusho Corporation, Toyota's trading house, set out to find alternative sources of rare earths by dispatching teams to Canada, Australia, and Vietnam [8]. Other Japanese companies soon followed suit.

In 2008 Toyota Tsusho and Sojitz Corporations established a joint venture with Coal and Mineral Industries Group (Vinacomin), a Vietnamese state-run company. In exchange for financial and technical support, Japan acquired the right to mine REEs at the Dong Pao mine in Lai Chau province, Vietnam. Mining operations could begin in Dong Pao as early as 2011 [9]. Sumitomo Corporation, Japan's third largest trading company, recently launched a feasibility study on a mine in Yen Bai, located in the northern province of Vietnam. They are expected to start exporting rare earths to Japan as early as 2013 (Vietnam Business and Economy News, January 7).

Sojitz Corporation also signed a contract with Lynas Corporation, an Australian mining company, which owns the Mount Weld mine (The Daily Yomiuri Online, December 9, 2010). Mitsubishi signed a contract with Molycorp, which owns the Mountain Pass Mine in California, to import 750 tons of rare earths yearly [10]. These are just a few examples. There have been many other deals between Japanese companies and leaders and the countries of Kazakhstan, Namibia and India, and Mongolia (Reuters, July 30, 2010; Jiji Press, November 19 2010; The Daily Yomiuri Online, December 9, 2010).

The Japanese government has also stepped in by creating a $1.25 billion integrated policy to try to mitigate any future disruptions. According to Mr. Shigeo Nakamura, president of the Advanced Material Japan Corporation, $490 million is going toward improving the production of REEs through technological innovation. $370 million is going toward supporting Japan's foreign rare earth mining ventures. Japan is also planning to spend money on research and development to come up with alternatives and other projects [11].

Recycling Rare Earth

The temporary ban of shipments of rare earth to Japan has had some leading companies focusing on recycling. Hitachi, hopes to meet 10 percent of its rare earth needs through recycling by 2013. Mitsubishi Materials

Corporation began researching costs associated with extracting dysprosium and neodymium from washing machines and air conditioners.

One criticism of recycling rare earths is the cost. Most applications use such small quantities of rare earth that it is unlikely to be economical to recycle. For example, in cell phones, the 0.3 gram NdFeB magnet used to make the phone vibrate contains only about 0.1 gram of neodymium [12]. On the other hand, some applications require significantly greater amounts of REEs which would make them ideal candidates for future recycling. For example, MRI machines use two to three tons of the NdFeB magnets.

Developing Alternative Materials

Japan has been developing alternative materials that do not rely on REEs. For example, Toyota and Tesla Motors are in the process of developing an induction motor that does not rely on such elements.

Intermetallics Co. Ltd, a research and development company that specializes in permanent magnets, is developing a technology that could reduce the amount of dysprosium used in electric-motor magnets without affecting performance. Dysprosium can be added to NdFeB magnets to increase the coercivity of the magnets, which make them able to withstand greater temperatures before losing magnetic properties (Nikkei Telecom 21, October 22, 2010).

Conclusions

Despite an easing of tensions between Japan and China over the Senkaku Diaoyu Islands, some experts believe that a return to a free flow of rare earths from China's mines is unlikely for various reasons. The two countries share a history of bitter feelings and mistrust. Additionally, Chinese analysts believe that Japan has been hoarding REEs. According to a Chinese report, Japan imports about 92 percent of its rare earths from China. Yet, Japan uses only one third of its imports for production, with the rest going toward strategic reserves (Qingnian Cankoa, November 9, 2010).

Experts believe that Japan should be able to stop worrying about supplies of REEs by 2012 or 2013. Kingsnorth predicts that between 2010 and 2013/14, the ROW rare earth production will increase tenfold from 4 to 6,000 tons of rare earth oxides produced annually to 40-60,000 tons. According to Kingsnorth, for the ROW to be self sufficient in 2020 then ROW supply will have to triple between 2013/14 and 2020, representing a 30-fold increase in the next ten years. Through its efforts over the past five years, Japan is paving the way to ensure it does not suffer any future shortfalls. The potential suppliers would have to step up the plate as well [13].

Finally, no one wants to be beholden to China anymore. As Japan forges ahead, it could well spark a new form of competition against China. Japan has long been a leader in technology and innovation. As Japan, through its technological prowess, regains its production capacity and weans itself off of China, it will continue to develop alternative technologies that might one day rival current technologies. It could be that the move to self-reliance may see other countries' manufacturers moving upstream as well in order to secure reliability of supply; a reversal of the trends of the past two decades.

[The views expressed in this report are those of the author and do not necessarily represent the official policy or position of the Department of the Army, Department of Defense, or the U.S. Government.]

Notes:

1. Dudley Kingsnorth, "Rare Earth Opportunities – Real or Imaginary?" BBY Rare Earths Conference, April 2011.
2. For more information on why China has been cutting back export quotas, see Cindy Hurst, "China's Rare Earth Elements Industry: What Can the West Learn," Institute for the Analysis of Global Security, March 2010.
3. Shigeo Nakamura, Rare Earth Statistics of Japanese Market in 2006, a presentation at the Beijing Conference of Minor Metal 2006, September 7, 2006; and Yuka Hayashi and James T. Araddy, "Japan Scrambles for Rare earth," Wall Street Journal, October 15, 2010.
4. Eiji Nakamura, "The History of Rare Earths in Japan," a presentation given during the Tokyo Rare Earth Conference, 2010.
5. At the time this report was written, the final tally had not been determined.
6. "Hybrid Electric Vehicles," Molycorp website, accessed February 6, 2011, www.molycorp.com/hybrid_ev.asp.
7. Ibid.
8. Ibid.
9. "Coverage from Minor Metals & Rare Earths 2010 – Xiamen, China," Rare Metal Blog, October 22, 2010; and Shigeo Nakamura, "Current Trends in the International Rare Earth Market, Rare Earth Conference in Tokyo, December 7, 2010.
10. Ibid.
11. "Coverage from Minor Metals & Rare Earths 2010 – Xiamen, China," Rare Metal Blog, October 22, 2010; and Shigeo Nakamura, "Current Trends in the International Rare Earth Market, Rare Earth Conference in Tokyo,

December 7, 2010.
12. Dudley Kingsnorth, Telephone Interview, September 24, 2010.
13. Dudley Kingsnorth, email correspondence, April 21, 2011 and Dudley Kingsnorth, Rare Earth Opportunities – Real or Imaginary?"